

**ADAPTIVENESS IN VIRTUAL TEAMS:
ORGANISATIONAL CHALLENGES AND RESEARCH DIRECTION**

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Adaptiveness in Virtual Teams: Organisational Challenges and Research Direction

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Abstract

Computer supported teams are capturing the attention of academics and practitioners as organisations increasingly put them into practice as virtual teams. The practical relevance of current research into computer supported teams could be increased if greater attention is paid to organisational challenges as they form the context within which virtual teamwork takes place. A model of organisational challenges mapped against processes of adaptation is developed to highlight principle factors affecting virtual teams. A sample of current research groups studying computer-supported teams is plotted onto this map to reveal the extent to which current research addresses these contextual factors. From this map insights are distilled with respect to what is known and is not known about virtual teams. This paper concludes with specific research needs in the study of virtual teams.

Introduction

Virtual teams have captured the imagination of academics and practitioners for their potential to enable work across distances, time zones and geographical and organisational boundaries with links strengthened by webs of communication technologies (Lipnack and Stamps 1997). Some go so far as to suggest that virtual teams provide opportunities to mobilise hidden manpower (Eom and Lee 1999). However, before we draw such conclusions, several problems and questions need to be addressed, many of which are technologically oriented. By the nature of their distributed existence, virtual teams are

supported by group and/or electronic communications technologies that impact team dynamics. Other issues are related to characteristics of the work these teams are engaged in and the organisational and social environment in which they reside.

Zigurs and Qureshi (2000:6) suggest that "virtual teams are not really teams, but individuals brought together through technology. Virtual work does not have the traditional characteristics of work in an organisation, surrounded by people and the hustle and bustle of work activity; instead it takes place in a workspace that is of one's own configuration and time. Virtuality is now associated with activities that can take place anytime, anywhere, and anyway one desires, with no physical, geographical, or structural constraints." How, then, do individuals brought together through technology function as a team in this virtual workspace? What are the impacts of Group Support Systems (GSS) and other technologies designed to support teams? What are the identifying characteristics and adaptations that occur as individuals use technological support to function as a virtual team? And what are the social consequences?

Research on the nature of teams in traditional organisations provides a background from which to address some of these questions. Further, there is a growing body of research on the application and implications of group support technology that has relevance to distributed teams (i.e. Nunamaker et al 1997, Hiltz and Turroff 1992, Malone and Lai 1992, Eom and Lee 1999). Current research considers virtual teams within traditional organisational environments as well as within emerging networks of interrelated activities that take place anytime, anywhere, and with few geographical, or structural constraints. Research has embraced a range of positivist and interpretivist perspectives and approaches. These different aspects of research appear to form a gigantic puzzle with each research group focussing on their own particular notion of virtual teams using their preferred research approach. Opportunities exist to bring these research contributions together to address the complex nature of virtual teams and their work in organisational contexts.

This paper explores the key contextual factors affecting virtual teams by considering the challenges faced by organisations today, mapped against potential constraints and opportunities posed by the technology. As will be discussed, the dynamic nature of these organisational challenges require a

constant adaptation on the part of virtual teamwork. In particular, the main question addressed by this paper is: how do computer supported virtual teams adapt to change?. When these processes of adaptation are mapped against organisational challenges, a set of principal factors emerge that require consideration for conducting and evaluating relevant research into virtual teams. A sample of research groups studying collaborative technology support for teamwork are plotted onto this model to reveal a map of the principle factors of current research. This paper concludes with insights about virtual teams and specific research needs in the study of computer support of virtual teamwork.

Theoretical Foundations

In their review of electronic communication and changing organisational forms, Fulk and DeSanctis (1995) suggest that new technology brings about changes in relations between organisations and in the organisational form itself. Within the organisational form itself, they describe the formation of leaner forms of organisations associated with the flattening of hierarchies and the decline in administrative support staff. This includes greater horizontal coordination related to electronic workflow, concurrent engineering, stock-less production and the rise of computer supported and even virtual organisations. In addition, distributed technologies such as e-mail have been active in facilitating the informal diffusion and dissemination of information throughout organisations and some argue that this brings about more egalitarian beliefs and aspirations. (Clement 1994, and Schuler 1994). While these technologies have been instrumental in refining formal group processes, they may at times also reproduce hierarchical relationships by strengthening existing superior-subordinate relationships (Perin 1991). Further to such studies, Fulk and DeSanctis (1995) identify an overall reduction in the size of organisations and the emergence of new types of coupling. In this environment, the core organisation either spins off a leaner more flexible organisation or creates federated organisations by decentralising some operations and centralising others.

In view of these developments, Fulk and DeSanctis (1995) outline four major areas in which the application of new electronic communication technologies in organisations needs to be investigated. They identify: 1) the study of how organisations emerge, evolve and dissolve over time as being central to organisational form development; 2) situated studies which address the varying organisational arrangements in which electronic communication systems are used; 3) alternative design approaches for

new communication technologies; and 4) work life in the new organisational form. In building upon this system of classification, we have identified five key challenges facing modern organisations as they adapt to a virtual team environment. Stated briefly, these are: 1) the organisational *structure* within which GSS may be used; 2) *specialisation* of parts which are seen to require integrating mechanisms; 3) *coordination* between the different parts and of content; 4) *tasks* or processes carried out through the use of specific knowledge and expertise; and 5) *learning* seen as an adaptability to change and an ability to build up a collective reservoir of knowledge and skill. These challenges are by no means exhaustive, but appear to be those that reoccur in the literature and practice (Argyris 1980, Charan 1990, Child 1988, Drucker 1988, Holland and Lockett 1997, Nolan and Croson 1995, Zuboff 1988).

Structure

The move towards smaller, more numerous, more decentralised units is seen by many to suit the complex and information-rich nature of modern organisations. A pressure towards numerous, smaller, decentralised units results from the increasingly recognised importance of heterogeneous teams comprised of individuals representing different functions and skills. Often these teams are dispersed across different parts of the organisation. This becomes more relevant as the structure of organisations is recast to include higher degrees of collaborative team-work. Nolan and Croson (1995) state that the actual work of the firm is often accomplished by self-designed teams of professional knowledge workers who subcontract tasks from the executives and draw upon the information technology infrastructure for resources.

Another restructuring currently taking place within organisations is a move towards network forms. Some network forms appear within and others in between organisations. Either way, this reshaping is becoming increasingly popular as it is seen to complement a move towards greater flexibility and competitiveness (Charan 1991, Sproull and Keisler 1991). Network forms appear to be more readily supported by electronic communications technology for the management of its dispersed parts. Specifically, this form of organisation 1) enables geographically dispersed members to work together, 2) provides a virtual space or forum for communication, and 3) may enable the creation and maintenance of an identity and structure for organisations that cannot be identified through a building or physical boundary. In addition to these points, there are numerous areas in which effective team support is enabled by network structures in organisations. Team building and establishment of trust are key

considerations. Madkin, *et al.* (1996) distinguish between five types of teams (Work Teams, Product and Development Teams, Parallel Teams, Management Teams, and Ad Hoc Networks), each of which exhibits varying degrees of permanence, structure, processes, coordination and support needs. As such, the appreciation of group support features varies according to the needs of the organisation. Minimal critical structure, for example, may vary according to the phase and activity of the team, as may the type and degree of audio, video and data technology provided.

Specialisation

A commonly accepted view that has been put forward by authors such as Galbraith (1973) and Lawrence and Lorsch (1967), is that organisations respond to uncertainty by specialising their parts. Holland and Lockett (1997) identify varying degrees of asset specificity or the extent to which an investment is unique in the five cases which they studied. They detect a high degree of asset specificity in the electronics and retailing organisations and conclude that information systems are being used to manage the interdependencies more effectively, resulting in information asset specificity. Specialisation is also seen to require the existence of integrating mechanisms to enable the different parts to operate in synchrony, and to coordinate their activities. Personnel departments are considered to be formalised integrating mechanisms (Lawrence and Lorsch 1967) that have traditionally taken up this role by ensuring job mobility within an organisation. More recently, they have taken on the more informal, yet in many ways more significant, role of distributing information. Information has the effect of an informal, undefined integrating mechanism. In this, collaborative technology support may be seen as a means of facilitating information exchange and thus the integration of parts of the organisation.

A number of issues and questions become salient as specialised parts of organisations tend to develop their own “language” and terminology. For example, does use of videoconferencing remove ambiguities that might otherwise disturb the development of effective interpersonal and group communication? Some text-based GSS have historically used a “group dictionary” to overcome differences in interpretation. Group members refer to the dictionary if they are unsure of a term, or wish to provide their own definition. This becomes particularly important in cross-cultural communications in multinational organisations (Mejias, *et al.*, 1997). An additional set of issues deals with message content. Message content may be formulated and or altered as a consequence of specialisation of parts in an organisation. What, if any, structures and protocols are introduced as organisations strive to manage

disparate areas effectively, efficiently, and confidently? What kinds of technology become more or less important to these endeavours? Ultimately, it is interesting to reflect on changes in specialisation over time. With the increase in distributed technology advancements, do we begin to see more or less specialisation of parts in organisations? Evolutionary patterns may begin to emerge as appropriation of collaborative technology increases.

Coordination

As distributed teamwork expands, more information is now required for the purpose of coordinating and controlling various parts of an organisation. According to Simon (1976), in order to be successful, the behaviour of a group of people should not only involve the adoption of correct decisions, but also that all members of the group carry out the same decisions. Coordination, he claims, may be either procedural or substantive in nature. Procedural coordination establishes the lines of authority and outlines the sphere of activity of every member, while substantive coordination specifies the content of an individual's work. An organisational chart specifying reporting relations is a form of procedural coordination whereas, substantive coordination may range from guidelines for the design of a product to blueprints in factory production processes. Differentiation of the parts of an organisation and their diversity raises the level of information required for coordination and integration. In this, the technology alone cannot provide coordination and integration. Galbraith (1973) suggests that as an organisation faces new and different situations, operating rules and procedures have to be supplemented by coordination devices. Holland and Lockett (1997) see coordination to be the process by which strategic choices are made for coordinating economic activity. The use of information technology in achieving maximum coordination reflects the unique characteristic of each organisation as it innovates in order to remain competitive.

Coordination issues relevant to collaborative technology support include formal mechanisms such as structuring of communication, and preparation in advance of meetings and informal mechanisms such as the "grapevine" interaction. Informal coordination through "Chat boxes" may be used as a means of sustaining coordination without unduly adulterating content. Other systems encourage the use of audio or videoconferencing as a coordinating mechanism for same-time sessions. This may be useful for increased reliance on heavier content structuring and instructions or to overcome coordination difficulties in different-time sessions. Another approach to addressing coordination is through protocols.

This suggests that the use of group technologies must be complemented with facilitation, moderation mechanisms and appropriate guidelines for chairing. In addition, rules and procedures are required for structuring electronically supported teamwork. For example, international trade transactions have historically abided by fixed procedures, feedback mechanisms and checks and balances to assure effective coordination. These inter-organisation coordination mechanisms may also satisfy intra-organisation needs as the use of distributed group support systems become more widespread.

Task

Within the current restructuring of organisations, the function of labour is being transformed. Labour is no longer just a unit of production or a resource available for production, but is taking on a more refined role. The worth of an individual is no longer entirely determined by their skill and the amount that they produce. It is becoming increasingly apparent that a mixture of skills, the ability to acquire new skills and the ability to access, possess, and use appropriate knowledge and information, are required to achieve changing targets for performance. Drucker (1988) refers to the workforce of this type as knowledge specialists because every individual possesses a specific type of knowledge and skill that is necessary to perform the tasks that are allocated. These workers are referred to as information workers (Zuboff 1988) as they produce and have access to the basic information that is specific to their responsibilities; an essential element to the efficient functioning of an organisation. It is not only possible for individuals at lower levels of the organisation to make important decisions, but it is increasingly becoming a necessity. Decisions based on skill and expert knowledge are required on every level in order to ensure productivity or quality gains and appropriate responsiveness.

Learning

These developments also necessitate that organisations develop an ability to learn, an ability to acquire information, and to develop and remember how to use it for problem solving and decision making. The importance of this cannot be underestimated, especially given the need for organisations to increase their collective reservoir of knowledge and skill. Along with the changing role of information, the character of information is changing. The need for larger amounts of information is apparent in most modern organisations where there is a build up of too much information to too little effect. It is increasingly becoming a concern within most organisations today that the individuals within should have access to relevant information when it is required. It is a matter of knowing how to learn (Argyris

1980). In this, the technology alone cannot sustain these changes unless coupled by consistent learning processes that provide the organisation (and possibly those organisations associated with it) with the flexibility and adaptability to changing circumstances and competitive position. While certain types of behaviour are enabled by the electronic medium of communication, the changing work process also influences behaviour setting into motion double loop learning in which the way of working and the norms underlying the work practices are modified. In this, an issue considered paramount by Morrison, Morrison and Vogel (1992) is how to develop an organisational memory that serves the organisation and encourages learning without stifling emergent ideas. Being able to find information as well as creating an organisational climate that encourages information sharing with consistent rewards becomes necessary.

In the following diagram, the political constraints and opportunities for each supporting group are delineated for each of the organisational challenges discussed:

Table 1: Organisational Challenges in Computer Support for Virtual Teamwork

Challenges	Constraints	Opportunities
Structure	The use of GSS may bring additional complexity into the work environment.	Support teams with varying degrees of permanence. May facilitate teambuilding and networking processes.
Specialisation	Different communication protocols and “languages”.	Integration of parts of the organisation.
Coordination	Heavy content structuring required in distributed different-time sessions. May be incompatible with organisational coordination strategy.	More information may be made available for coordinating parts, although use should be complemented with conventions for interpersonal communication.
Task	Information accessibility may vary. Ability to use the technology and adapt to it may be difficult.	Process gains in terms of parallel communication, organisational memory and structuring of communication.
Learning	Organisational climate may stifle emergent ideas and prevent adaptability to changing circumstances and competitive position.	Greater flexibility and adaptability to change.

Structuration theory (Giddens 1984) is useful here in that it provides a means of understanding social processes that influence the ways in which collaborative technologies may be used. At the same time structuration theory sensitises this research in that it recognises a dual relation between technology and the creation of social structure. It suggests that while the use of technology may be influenced by social processes, these processes are also influenced and sometimes even created or destroyed by the same

technology. A particular application of structuration theory to computer mediated communication is offered by DeSanctis and Poole (1994). They propose a 'Theory of Adaptive Structuration' which states that as group members use GSS to complete a task, they are developing and applying rules and resources for the conduct of behaviour. The rules and resources of the group direct members as to which features of the technology they should appropriate. DeSanctis and Poole (1994) found that when individuals in a group interact using GSS, each group produces and reproduces its own *structures-in-use*. This process, they claim, accounts for the continual changing nature of social structures involved in virtual teams. In this research, three types of social processes are seen to affect the ways in which virtual teams adapt. These are technological, work and social adaptation.

Technological Adaptation

Technological adaptation occurs when people learn how to use the technological tools available and achieve their communication aims despite technological limitations, such as restricted bandwidth and lack of turn yielding cues. Argyris (1980) suggests that experience with information technology leads to greater organisational learning through adjustment. Using Argyris' (1980) terminology, it appears that technological adaptation involves single-loop learning, in which group members adjust their procedures according to changes in the environment. This brings about a modification in their collective knowledge but not in their norms and values. It appears that if more flexible tools for problem-solving and decision-making are made available, the collaborative technology could be adapted to a greater extent. The converse may also be true in situations where poor media is required to ensure that interaction remains focussed and does not fall prey to political meandering (Qureshi 1998). Technological adaptation is important as organisations question what to keep and what to throw out, as well as what form to chose from, i.e., audio, video, or data .

Work Adaptation

The process of work adaptation occurs when people adapt the technology to their own ways of working. While certain types of behaviour are enabled by the electronic medium of communication, the changing work process also influences behaviour. This stimulates double loop learning (Argyris, 1980) in which the way of working and the norms underlying the work practices are modified. The use of collaborative technology brings about new ways of working and accomplishing tasks. The process of work adaptation comes into play when groups and individuals are involved in changing organisational

patterns, including norms and values, while using the collaborative technology. This process also involves a reassessment of how the groups see themselves and their role in the organisation or a set of organisations. In addition to double loop learning, the process by which groups adapt to a work environment supported by collaborative technology brings about certain types of behaviour enabled by the electronic medium of communication and the changing work process. In this, learning modifies the way of working and the norms underlying established work practices. The process of adaptive structuration has a dual affect on the work process in that it effects the work process itself and the way in which work is carried out.

Social Adaptation

Social adaptation is the creation of patterns of interaction, including particular sets of rules and knowledge that the group members transfer social encounters on the electronic medium. The electronic media enable a social system to manifest itself. The identity of the group takes shape according to the social norms that emerge on the electronic space, giving rise to particular sets of rules and knowledge that the group members bring with them. These social encounters on the electronic medium amongst other less frequent personal encounters, can be seen to result in what Giddens (1984) terms as, *combined human action*. This, he claims, brings about patterns of interaction that then become established as standard practice. In the international network of organisations and linked educational teams (Qureshi and Vogel 2000), the collaborative technology served as a forum for the learning mechanisms that enable collaboration, the exchange of information and access to resources. Argyris' (1980) terms this as *duetro-learning* which is a continuous process of learning in which groups apply single-loop and double-loop learning interchangeably. This process is seen to give rise to a new social environment. Within this emerging social environment, social adaptation affects the way in which groups learn to use the technology, adapt it to their way of working and then adapt to an evolving and sometimes challenging technologically-enhanced. A key issue to effective social adaptation is what sort of communication etiquette and norms of behaviour evolve on the electronic social space and which of these is most conducive to the creation of technology-supported learning environments. This is a quest being explored in academic domains, with applicability in organisational learning situations (Alavi, Yoo, and Vogel, 1997).

When virtual teamwork is viewed from these three processes of adaptation, a number of issues arise. These issues are the result of a mixture of experiential knowledge and the literature in virtual teamwork (Applegate 1992, Bjorn-Andersen and Turner 1994, Jarvenpaa et al 1998, Lipnak and Stamps 1997, Nunamaker et al 1997, Orlikowski 1996, Qureshi 1998, Sproull and Kiesler 1991). These issues are summarised in the following table, categorised according to the technology itself, the work process and the social forces affecting the virtual teamwork.

Table 2: Issues in Computer Support for Virtual Teamwork

Technological	Work	Social
<p>Differences in speed and access to information.</p> <p>Functionality: Learning how to use and cope with the constraints posed by the technology and how to modify its capabilities.</p> <p>Ease of Use: Adapting to the technology.</p> <p>Security and integrity considerations.</p> <p>Communication protocols for facilitation, moderation and chairing.</p> <p>Communication confusion resulting from specialisation specific "languages".</p> <p>Ambiguities in distributed interpersonal communication.</p> <p>Mechanisms for managing interdependencies and integrating specialised parts.</p> <p>How message content is altered through the technology.</p> <p>Emerging patterns through use of the technology.</p>	<p>Fit with existing work practice.</p> <p>Performance measurement.</p> <p>Task orientation, sense of task goals.</p> <p>Individual initiative and accountability.</p> <p>Channels necessary to sustain coordination in virtual teams.</p> <p>Conflict management.</p> <p>Accuracy of information: Conveying meaning and salience.</p> <p>Level of content structuring.</p> <p>Sharing and accumulation of remote skill and expertise.</p> <p>Mobilisation of dispersed resources.</p> <p>Negotiation vs. fixed procedures.</p> <p>Feedback mechanisms, checks and balances.</p> <p>Support for knowledge work at different places and times.</p> <p>Providing access to work specific information.</p> <p>Level of experience and satisfaction.</p>	<p>Sustaining informal communication without adulterating content.</p> <p>Trust and cohesiveness.</p> <p>Sustaining shared context – mechanisms.</p> <p>Develop organisational memory without stifling emergent ideas.</p> <p>Adapting to an electronic social space while evolving different types of standard practices such as communication etiquette.</p> <p>Learning environments to provide organisations with the flexibility and adaptability to changing environments.</p> <p>Conflict through rivalries, territorialism and resistance to change and/or outsiders.</p>

The issues listed in the above table are by no means exhaustive and it must be recognised that they reflect the dynamic changing nature of virtual collaborative work. These issues of adaptation are not isolated and are evolving in accordance with the organisational challenges discussed earlier. The technology is continuously being upgraded and offering new possibilities for teamwork. At the same time, work itself evolves to reflect changes in technologies and patterns of social interaction. In the following table 3, we develop the technological, work and social issues further to reflect the organisational challenges. This table depicts the principle factors that need to be investigated if we are to arrive at theory-based and practically relevant knowledge concerning the value of virtual teams.

Table 3: Adaptation and Organisational Challenges in Computer Support for Virtual Teamwork

	Technological	Work	Social
Structure	Electronic communications network infrastructure enabling any time / any where connectivity.	Numerous, smaller decentralised units resulting from virtual teamwork.	Reporting, linking or control mechanisms for virtual teamwork.
Specialisation	Interoperability of different communication protocols.	Job mobility, reciprocal and sequential interdependencies.	Emergence of trust and virtual teamwork as a formal channel of communication.
Coordination	Collaborative technology, group support and/or electronic communications design and development.	Task allocation based on skill and expert knowledge.	Emerging conventions for content structuring and interpersonal communication.
Task	Tools for information storage and accessibility according to task requirements for information availability and access to relevant skill and expertise.	Facilitation of the content of virtual teamwork combined with moderation and chairing.	Communication etiquette and ability to exchange knowledge electronically.
Learning	Development and effective use of organisational memory and learning mechanisms.	Adaptiveness to new virtual team-working relations and continuous readjustment.	Responsiveness to change and creation of combined action.

The above factors can be seen to fall into a number of different types of research areas. Research into communication through the computer network whereby people do not physically meet or see each other can be provided within *virtual structures*. This research falls into Computer Supported Cooperative Work (CSCW) research programmes also sometimes referred to as Computer Mediated Communications Systems (CMCS). As defined by Hiltz and Turoff (1992), "these (CMCS) systems use computers and telecommunications networks to store, deliver, regulate and process communication among the group members and between the computer and the group". A CSCW system aims at

facilitating human interaction by increasing and improving communication between members of a group, by providing communication channels, by processing information and by structuring the processes in the group, i.e. determining or clarifying important issues for the group (Ellis *et al.* 1991). Another research area that investigates electronically supported teams uses a particular set of collaborative technologies known as GroupWare (Grudin 1994). The term GroupWare encompasses both face-to-face and distributed support for collaborative work. In general terms the research carried out by both sets of research groups consider the design and development of collaborative technologies as well as their use in organisations. Another emerging research stream that is very strongly connected to GSS research is the use of modelling or dynamic modelling techniques. These explorations support the collaborative design of organisational processes, policy making and strategy development. The following sections draw from an international sample of research groups to investigate the extent to which these developments address the contextual factors described above and illustrated in table 3.

Selection of Sample Research Groups

Research groups studying collaborative technology support for teamwork using CSCW, CMCS and GSS were selected from internationally renowned forums such as conferences and leading journals in the IS field. The criteria for the selection of the sample of research groups was as follows:

1. There was an established record of research in collaborative technology support for teamwork. This record was based on an extensive literature review and substantiated with web sites and/or other material such as manuals.
2. The research groups were based in universities. This indicates that there is some sort of continuity of the research groups and a degree of 'quality control'.
3. There appeared to be practical relevance in the research being conducted. Practical relevance was largely ascertained from evidence of externally funded research projects and/or studies that took place within external organisations.
4. The research output had a well-grounded theoretical and empirical basis. Research groups that concentrated on collaborative systems design and development only were not included in this sample as were research groups only concerned with theory development.

The resulting sample of universities with groups conducting research in collaborative technology support for teams is listed in Appendix table 5. The participating universities were then grouped according to

organisational challenges to create the model of Adaptation and Organisational Challenges in Virtual Teamwork (illustrated in Table 3). These results are illustrated in table 4 in the Appendix.

Current Findings and Future Research Needs

The picture is rapidly changing both within the focus of research groups that have historically dominated GSS research and new emergent research groups. In part, this is a reaction to changing times as well as changing technologies. The technology has also matured considerably, becoming more cost-effective and readily available over the past years, which further encourages investigation in distributed contexts. The Internet is now acting as a transport and support vehicle for a wide range of group support systems. As these varied research groups focus attention on aspects of virtuality, it is natural to see a broader range of methodologies and issues being investigated at organisational and societal levels in addition to individual and team levels. The contributions of these research groups with respect to what we know and do not know about virtual teams are summarised in the following paragraphs. Questions and suggestions for future research are offered.

Research into the computer support of teams has been dominated by a positivist approach. As such, these studies have predominantly focused on examining the use of GroupWare technology compared to no technological support or the implications of particular Group Support Systems (GSS) features. For example, Zigurs, *et al.* (1988) studied *influence and ability to generate consensus* on a resource allocation task in the presence or absence of a GSS. Further studies addressed the implications of group size as well as group member proximity (e.g., Nunamaker, *et al.*, (1991b), Chidambaram, *et al.* (1991), McLeod and Liker (1992)) and examined changes in the ability of groups to manage conflict and differences in group cohesion over time as a function of the use of GSS versus no GSS. Connolly, *et al.* (1990) examined the ability of groups to *produce unique ideas* while varying participant anonymity (present or absent) and protocol i.e., members were encouraged to be only supportive of the ideas of others in one treatment or were encouraged to challenge the ideas of others.

The research carried out by Chidambaram and Bostrom (1993), Connolly *et al.* (1990), Zigurs *et al.* (1998) and Nunamaker *et al.* (1991) has shed valuable light into factors affecting *performance* in teams. Factors such as satisfaction, task structuring, anonymity, parallel communication, and group

memory increase group performance over time. The question still remains as to how do we assess the *productivity and performance* of virtual team members especially in situations where their contributions are not clearly recognisable or anonymous ? While the benefits of virtual teamwork may be enticing, effective performance appraisal and remuneration mechanisms are still in their formative stages.

Trust is an important issue particularly when virtual teams are globally dispersed. Jarvenpaa *et al.* (1998) found that virtual teams do not really need 'high trust' in a traditional sense. 'Swift trust' takes place, which is very much task-oriented and yet empathic enough in order to achieve good performance. Teams with 'swift trust' comment seriously and in a constructive way on their work with other participants. However what we still do not know about virtual teams is how this trust is fostered in particular, how it emerges within the electronic spaces that have become so varied and prevalent.

Another challenge that needs to be considered is establishing extended **presence** in virtual teams. Zigurs and Qureshi (2000) suggest that while the technology may be provided to enable virtual teambuilding, little else is done to ensure that person's continuing organisational presence. This telepresence needs more *presence*. A richer telepresence can provide an opportunity for individuals to present a more complex persona in their interactions, and that persona might change for different audiences.

Virtual teamwork also requires careful attention to **facilitation** mechanisms for enhancing group performance. The research of authors, such as, Eden and Ackermann (1992), Niederman *et al.* (1996), Nunamaker *et al.* (1991), Dean *et al.* (2000) and Vreede, de (1998) have investigated both structured and unstructured mechanisms for facilitating group meetings. Their work has shown us that facilitation is one of the most important factors affecting the success of computer supported meetings. However, for electronic group meetings, which are distributed across space and time, careful investigation of facilitator presence and mechanisms for facilitation are required. This is particularly important if facilitation and an interactive structuring of group processes are seen to affect the success of virtual teamwork.

Different *cultural considerations* appear to play an important role in virtual teamwork. In their investigation of GSS supported Singaporean teams in relation to GSS supported American teams, Watson *et al.* (1994) propose culture to be an important fourth dimension in GSS research. Further to this research, Mejias *et al.* (1997) considered the cultural effects of Mexican and American students. While cultural considerations among team members of different nationalities are important, the question still remains as to how important are national cultures in an increasingly networked world? Research into the evolving norms and behaviours of electronic social spaces would shed light onto those emerging cultures that play an important part in the success or failure of virtual teamwork, especially in the context of multi-cultural teams.

Organising work and coordination in virtual teams has been the subject of research by authors such as Sproull and Kiesler (1991), Hiltz and Turoff (1992), Holland and Lockett (1997), and Qureshi and Vogel (1998) who consider informal communication and coordination mechanisms in virtual teams. Researchers such as Schmidt and Simone (1996), Vreede, de (1998) and Malone and Lai (1992) consider more formal coordination mechanisms. However, the coordination challenge for virtual teams is in allocating tasks based on knowledge and skill in an environment that is often dispersed across space, time and organisations. Coordinating access to people and resources that are dispersed in this way is an area that requires research and practical application.

Once virtual teamwork can be effectively coordinated, the next step is to manage the change that comes with the transition to virtual teamwork. This comes with the challenge of *managing organisational change* to new organisational forms has been investigated by authors such as Lea *et al.* (1995), Markus and Benjamin (1996), Orlikowski (1995, 1996), and Qureshi (1998). These mostly interpretivist studies have been useful in providing insight into the contextual factors that shape collaborative technology in organisations and thus increasing the relevance of the resulting knowledge. A key lesson that we have learnt from such research is that change is inherent to virtual teams, of which only a part may be managed effectively. New possibilities that are provided by virtual workspaces include potential redefinition of the technology's original purpose and even its outright rejection. This means that virtual teams operate in dynamic places that are continuously being reshaped through the dual process of technology adaptation and changes in social structures. Increasingly, people wonder whether the side effects are not more significant than anticipated, if they are anticipated at all (Zigurs and

Qureshi, 2000). Research into managing virtual teams in network organisations and virtual organisations should consider the reduction and redefinition of space, time and organisational boundaries more carefully.

A growing challenge facing network and virtual organisations is *managing knowledge* that is dispersed across space and time and has to be employed collectively to achieve joint goals. A particular characteristic of interaction on virtual teams is that it is communication intensive. This means that knowledge creation in virtual teams requires reflection and discussion among a diverse group. The research of Alavi *et al.* (1997), Yap *et al.* (1998) and Qureshi *et al.* (2000) has thrown light on the personalised nature of knowledge creation in virtual teams and illustrated how this processes takes place through electronic spaces. However, research into managing knowledge through emerging network structures is still required as virtual teams continue to develop through network structures supported by increasingly powerful telecommunications infrastructures. The challenge for researchers lies in understanding the creation of virtual communities within which the creation of knowledge takes place and creation and maintenance of knowledge networks.

Further to the above research, Pervan's (1998) review of GSS research suggests that there is a clear need for more fieldwork and theory development. In particular, he suggests that interpretivist approaches have been almost ignored. In the words of Benbasat and Zmud (1999:6): "In order for IS research to be relevant, IS researchers must in some form or another be exposed to the practical contexts where IT-related usage and management behaviours unfold." However, because the results of interpretive research are restricted to specific contexts, many in the IS community find it difficult to generalise them across the field and package them into concrete recommendations.

In view of the positivistic and interpretivist research that has taken place into the use of electronic communication technologies, Lee (1991) proposes an integrated framework in which both positivist and interpretivist approaches can "play an active role in strengthening the other in a truly collaborative research effort" (1991:342). He proposes a layered model in which the subjective meaning of human behaviour in socially constructed settings are observed and interpreted by an interpretivist researcher. These interpretations, once tested against the real world subjective meanings, are used to build a positivistic understanding of human action through constructs. These constructs relate to predictive

models of human action or "puppets" and are then tested against the real world subjective understanding of the human subjects being modelled. While this model may be useful in extracting concrete results, it in essence imposes a deterministic, essentially positivist means of applying both approaches. It does this by 1) reducing the phenomenon being investigated into constituent parts, 2) trying to replicate the real world phenomenon (in models), and 3) testing the validity of each part. While both types of research perspectives may potentially strengthen each other, this paper goes a step further and suggests that the choice of research approach or combination thereof should depend upon the issue being investigated and not vice versa, thus increasing the practical relevance of research focused on virtual teams.

Conclusions

The research arena is expanding rapidly as organisations and academic institutions alike deal with extended issues in adaptiveness in virtual teams. To some, we are in a transient phase that is pushing out beyond the envelope of team fundamentals into a space where we begin to lose track of reality. Some would even call virtual teams an oxymoron, claiming that teams begin to lose their identity and existence as they leave the close confines of face-to-face interaction. Predictions of dire consequences are not likely, however, nor is immediate broad-based success. The broader implications of virtual teams remain to be studied and understood. Simply put, the issues are complex and there has been insufficient time and experience to draw strong conclusions. Research is helping explore the concept of virtual teams to remove uncertainties, an endeavour that should be encouraged to continue. None of the categories we have identified in this paper has been exhaustively researched by any means. There are most likely nuances that we are not yet sensitive to that will emerge.

The research group profile is also changing from a national to an international focus, as would be expected given enhanced attention to globalisation. More international variety in the research groups tends to broaden the types of issues being investigated, which brings forth a richer set of methodologies. This brings with it a broader range of research publication outlets as well as more variety with the traditional publishing sources. Overall, the research picture becomes much richer and less US centric with more attention to issues other than development and evaluation of tools, techniques and practices. As one would expect, cultural variations and considerations that span organisations and countries become salient issues. Finally, the historical research group profile also becomes murkier as new and less well-defined research groups enter into the picture and make contributions. In some cases these

groups are small with only a few individuals while in other cases they are part of a larger group with a broadened focus. Emerging as well are research groups that represent partnerships between institutions putting globalisation into practice.

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Appendix Table 4: Research groups in terms of organisational challenges and adaptation

	Technological	Work	Social
Structure	<i>Queen Mary and Westfield College UK</i>	<i>Massachusetts Institute of Technology, USA Harvard Business School, USA</i>	<i>Massachusetts Institute of Technology, USA Erasmus University Rotterdam, NL</i>
Specialisation	<i>University of Arizona, USA Roskilde University, Denmark</i>	<i>Copenhagen Business School, Denmark Harvard Business School, USA</i>	<i>Massachusetts Institute of Technology, USA University of Texas, Austin</i>
Coordination	<i>Massachusetts Institute of Technology, Centre for Coordination Science USA Roskilde University, Denmark Queen Mary and Westfield College UK</i>	<i>Massachusetts Institute of Technology, Centre for Coordination Science USA Delft University of Technology, NL</i>	<i>Massachusetts Institute of Technology, USA</i>
Task	<i>Indiana University, USA Massachusetts Institute of Technology, Centre for Coordination Science USA New Jersey Institute of Technology USA Queen Mary and Westfield College UK Roskilde University, Denmark University of Arizona USA University of Calgary, Canada University of Michigan USA. University of Minnesota USA University of Strathclyde, UK</i>	<i>City University of Hong Kong, HK Claremont University, USA Delft University of Technology, USA. Erasmus University Rotterdam, NL Indiana University, USA University of Arizona USA University of Baltimore, USA University of Calgary, Canada University of Colorado, Boulder, USA University of Georgia, USA University of Maryland, USA University of Michigan, USA University of Strathclyde, UK</i>	<i>Massachusetts Institute of Technology, USA Erasmus University Rotterdam, NL Harvard Business School, USA University of Texas, Austin</i>
Learning	<i>Indiana University, USA Massachusetts Institute of Technology, Centre for Coordination Science USA New Jersey Institute of Technology USA University of Arizona USA University of Minnesota USA University of Strathclyde, UK</i>	<i>City University of Hong Kong, HK Claremont University, USA INSEAD, France National University of Singapore, Singapore University of Baltimore, USA University of Maryland, USA University of Strathclyde, UK University of Texas, Austin</i>	<i>Claremont University, USA INSEAD, France University of Strathclyde, UK University of Texas, Austin</i>

Appendix Table 5: A Sampling of Research Groups and Streams

Universities	Research Groups
<i>City University of Hong Kong</i>	Technology support for collaborative learning in on-demand education and extension to support learning in culturally diverse organisational contexts. (Davison and Vogel, 2000)
<i>Claremont University, USA</i>	Technology support for groups extending to telecommuting environments. (Markus, L. and Benjamin, R. 1996. Gray, Vogel and Beauclair 1990)
<i>Copenhagen Business School, Denmark</i>	Examination of organisational elements of team support and business process improvement including electronic commerce in virtual organisations. (Bjørn-Andersen and Turner 1994, Yap, Alexander and Bjørn-Andersen 1998)
<i>Curtin University, Australia</i>	Examination of the role of facilitation in computer supported group settings. (Pervan 1998)
<i>Delft University of Technology, The Netherlands</i>	Application of GroupSystems use in a variety of business and government organisations and in collaborative design. (Vreede, de 1998, Vreede de, and Bruin de, in press)
<i>Erasmus University Rotterdam, The Netherlands</i>	Support of globally distributed project teams and management of knowledge through distributed CSCW environments. (Qureshi 1998, Qureshi and Vogel 2000).
<i>Harvard Business School, USA</i>	Potential technology applications from facilitating group communication to support of specific group communication and tasks. Case study at IBM. (Applegate 1992)
<i>Indiana University, USA</i>	Media effects of face-to-face group support. (Connolly, Jessup and Valacich 1990)
<i>INSEAD, France</i>	Development of trust in multi-cultural distributed teams. (Jarvenpaa, Knoll, and Leidner, 1998)
<i>Massachusetts Institute of Technology, USA</i> <i>Centre for Coordination Science.</i>	Organisational studies of collaborative technology in change (Orlikowski <i>et al.</i> 1995, Orlikowski 1996), and social processes in distributed teamwork. (Sproull and Kiesler 1991) Information and Object Lens: Intelligent tool support for managing electronic messages.(Malone and Lai 1992) Answer Garden: Tool for growing organisational memory. (Ackermann and Malone 1990) Sibyl: Tool for supporting group decision making. (Lee 1990) Hypervoice: Flexible interface for voice databases. (Resnick and King 1990).
<i>National University of Singapore, Singapore</i>	Investigation of the cultural impacts of group support systems. (Raman and Wei 1992)
<i>New Jersey Institute of Technology USA</i>	Conferencing and distributed group support and tool support: EIES. (Hiltz and Turoff 1992, 1993)
<i>Queen Mary and Westfield College UK</i>	Cosmos: Support for communication structure for multiple activities (i.e. meetings, co-authoring) through a Cosmos Information Service. (Wilber and Dollimore 1992).
<i>Roskilde University, Denmark</i>	Coordination mechanisms and conceptual CSCW systems design. (Schmidt and Simone 1996)
<i>University of Arizona USA</i>	GroupSystems: mostly face-to-face meeting support for use in universities and organisations and increasingly extended to distributed domains. (Nunamaker, Briggs, Mittleman, Vogel 1997; and Nunamaker, Dennis, Valacich, and Vogel 1991)
<i>University of Baltimore, USA</i>	Electronic meeting facilitation issues and concerns. (Niederman <i>et al.</i> 1996)
<i>University of Calgary, Canada</i>	Implementation and adoption diffusion dynamics associated with group support technology. (Gopal <i>et al.</i> 1992)
<i>University of Colorado, Boulder, USA</i>	Use and impact of computer-based technologies for supporting collaborative work, especially for group decision making. (Zigurs and Buckland, 1998)
<i>University of Georgia, USA</i>	A variety of explorations using web-based collaborative support tools including a focus on facilitation. (Bostrom, Watson, and van Over, 1992)
<i>University of Maryland USA</i>	Impact and implication of group support technology in educational settings. (Alavi, Yoo, and Vogel, 1997)
<i>University of Michigan USA</i>	Use of multi-media tools to support groups. (Olson, Olson, Killely, Mack, Cornell, and R. Luchetti 1992) and media effects (McLeod and Liker 1992)
<i>University of Minnesota USA</i>	SAMM: Face-to-face meeting support for teams in organisations and how they incorporate social technologies for their work. (Dickson, Scott-Poole and DeSanctis 1992, Zigurs, Scott Poole and DeSanctis, 1988)
<i>University of Strathclyde, UK</i>	CODE: Use of GroupWare for strategy development and implementation. (Eden and Ackermann 1992)

*University of Texas, Austin,
USA*

Development of trust in multi-cultural distributed teams. (Jarvenpaa, Knoll, and Leidner, 1998)

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